

McGRAW-EDISON

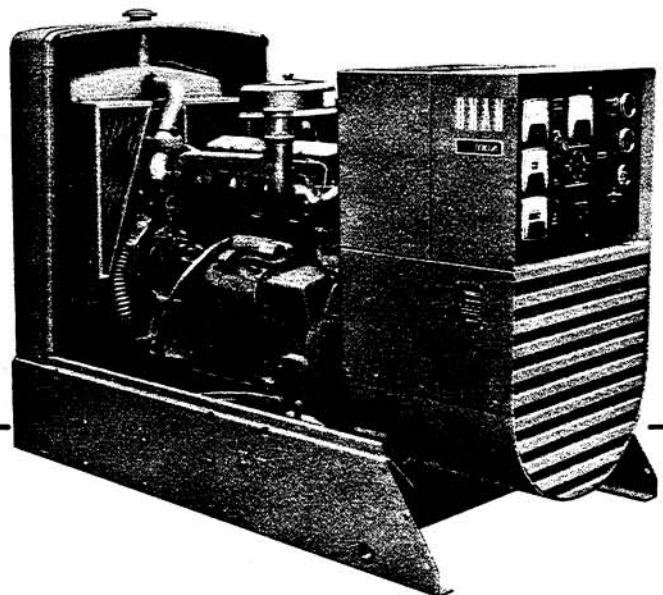
Onan

Operator's Manual

DDA and

DDB

GenSets



Safety Precautions

The following symbols in this manual signal potentially dangerous conditions to the operator or equipment. Read this manual carefully. Know when these conditions can exist. Then, take necessary steps to protect personnel as well as equipment.

Read your manual and become thoroughly acquainted with it and your equipment before you start your unit. These recommendations and the following safety precautions are for your protection.

Fuels, electrical equipment, batteries, exhaust gases and moving parts present potential hazards that could result in serious, personal injury. Take care in following these recommended procedures.

WARNING

This symbol is used throughout this manual to warn of possible serious personal injury or death.

CAUTION

This symbol refers to possible equipment damage.

General

- Keep your electric generating set and the surrounding area clean and free from obstructions. Remove any debris from set and keep the floor clean and dry.
- Provide appropriate fire extinguishers and install them in convenient locations. Consult your local fire department for the correct type of extinguisher to use. Do not use foam on electrical fires. Use extinguisher rated ABC by NFPA.
- Make sure that all fasteners on the generating set are secure. Tighten supports and clamps, keep guards in position over fans, driving belts, etc.
- Do not wear loose clothing in the vicinity of moving parts, or jewelry while working on electrical equipment. Loose clothing and jewelry can become caught in moving parts. Jewelry can short out electrical contacts; cause shock or burning.
- If adjustment *must* be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.
- Do not work on this equipment when mentally or physically fatigued.
- Coolants under pressure have a higher boiling point than water. DO NOT open a radiator or heat exchanger pressure cap while the engine is running. Bleed the system pressure first.

Protect Against Moving Parts

- Keep your hands away from moving parts.

- Before starting work on the generating set, disconnect batteries. This will prevent starting the set accidentally.

Fuel System

- DO NOT fill fuel tanks while engine is running, unless tanks are outside engine compartment. Fuel contact with hot engine or exhaust is a potential fire hazard.
- DO NOT SMOKE OR USE AN OPEN FLAME in the vicinity of the generator set or fuel tank. Internal combustion engine fuels are highly flammable.
- Fuel lines must be adequately secured and free from leaks. Piping at the engine should be approved flexible line. Do not use copper piping on flexible lines as copper will work harden and become brittle.
- Be sure all fuel supplies have a positive shutoff valve.

Guard Against Electric Shock

- Remove electric power before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surfaces to be damp when handling electrical equipment.
- Use extreme caution when working on electrical components. High voltages cause injury or death. DON'T tamper with interlocks.
- Follow all state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag open switches.
- DO NOT SMOKE while servicing batteries. Lead acid batteries emit a highly explosive hydrogen gas that can be ignited by electrical arcing or by smoking.

Exhaust Gases Are Toxic

- Provide an adequate exhaust system to properly expel discharged gases. Inspect exhaust system daily for leaks per the maintenance schedule. Ensure that exhaust manifolds are secure and not warped. Do not use exhaust gases to heat a compartment.
- Be sure the unit is well ventilated.

Keep the Unit and Surrounding Area Clean

- Make sure that oily rags are not left on or near the engine.
- Remove all oil deposits. Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and subsequent engine damage and may present a potential fire hazard.

Important Safety Precautions

Read and observe these safety precautions when using or working on electric generators, engines and related equipment. Also read and follow the literature provided with the equipment.

Proper operation and maintenance are critical to performance and safety. Electricity, fuel, exhaust, moving parts and batteries present hazards that can cause severe personal injury or death.

FUEL, ENGINE OIL, AND FUMES ARE FLAMMABLE AND TOXIC

Fire, explosion, and personal injury can result from improper practices.

- Used engine oil, and benzene and lead, found in some gasoline, have been identified by government agencies as causing cancer or reproductive toxicity. When checking, draining or adding fuel or oil, do not ingest, breathe the fumes, or contact gasoline or used oil.
- Do not fill tanks with engine running. Do not smoke around the area. Wipe up oil or fuel spills. Do not leave rags in engine compartment or on equipment. Keep this and surrounding area clean.
- Inspect fuel system before each operation and periodically while running.
- Equip fuel supply with a positive fuel shutoff.
- Do not store or transport equipment with fuel in tank.
- Keep an ABC-rated fire extinguisher available near equipment and adjacent areas for use on all types of fires except alcohol.
- Unless provided with equipment or noted otherwise in installation manual, fuel lines must be copper or steel, secured, free of leaks and separated or shielded from electrical wiring.
- Use approved, non-conductive flexible fuel hose for fuel connections. Do not use copper tubing as a flexible connection. It will work-harden and break.

EXHAUST GAS IS DEADLY

- Engine exhaust contains carbon monoxide (CO), an odorless, invisible, poisonous gas. Learn the symptoms of CO poisoning.
- Never sleep in a vessel, vehicle, or room with a genset or engine running unless the area is equipped with an operating CO detector with an audible alarm.
- Each time the engine or genset is started, or at least every day, thoroughly inspect the exhaust system. Shut down the unit and repair leaks immediately.

- Warning: Engine exhaust is known to the State of California to cause cancer, birth defects and other reproductive harm.

Make sure exhaust is properly ventilated.

- Vessel bilge must have an operating power exhaust.
- Vehicle exhaust system must extend beyond vehicle perimeter and not near windows, doors or vents.
- Do not use engine or genset cooling air to heat an area.
- Do not operate engine/genset in enclosed area without ample fresh air ventilation.
- Expel exhaust away from enclosed, sheltered, or occupied areas.
- Make sure exhaust system components are securely fastened and not warped.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not remove any guards or covers with the equipment running.
- Keep hands, clothing, hair, and jewelry away from moving parts.
- Before performing any maintenance, disconnect battery (negative [–] cable first) to prevent accidental starting.
- Make sure fasteners and joints are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.
- If adjustments must be made while equipment is running, use extreme caution around hot manifolds and moving parts, etc. Wear safety glasses and protective clothing.

BATTERY GAS IS EXPLOSIVE

- Wear safety glasses and do not smoke while servicing batteries.
- Always disconnect battery negative (–) lead first and reconnect it last. Make sure you connect battery correctly. A direct short across battery terminals can cause an explosion. Do not smoke while servicing batteries. Hydrogen gas given off during charging is explosive.
- Do not disconnect or connect battery cables if fuel vapors are present. Ventilate the area thoroughly.

DO NOT OPERATE IN FLAMMABLE AND EXPLOSIVE ENVIRONMENTS

Flammable vapor can be ignited by equipment operation or cause a diesel engine to overspeed and become difficult to stop, resulting in possible fire, explosion, severe personal injury and death. **Do not operate diesel equipment where a flammable vapor environment can be created by fuel spill, leak, etc., unless equipped with an automatic safety device to block the air intake and stop the engine.**

HOT COOLANT CAN CAUSE SEVERE PERSONAL INJURY

- Hot coolant is under pressure. Do not loosen the coolant pressure cap while the engine is hot. Let the engine cool before opening the pressure cap.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not service control panel or engine with unit running. High voltages are present. Work that must be done while unit is running should be done only by qualified service personnel.
- Do not connect the generator set to the public utility or to any other electrical power system. Electrocutation can occur at a remote site where line or equipment repairs are being made. An approved transfer switch must be used if more than one power source is connected.
- Disconnect starting battery (negative [-] cable first) before removing protective shields or touching electrical equipment. Use insulative mats placed on dry wood platforms. Do not wear jewelry, damp clothing or allow skin surface to be damp when handling electrical equipment.
- Use insulated tools. Do not tamper with interlocks.
- Follow all applicable state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag open switches to avoid accidental closure.
- With transfer switches, keep cabinet closed and locked. Only authorized personnel should have cabinet or operational keys. Due to serious shock hazard from high voltages within cabinet, all service and adjustments must be performed by an electrician or authorized service representative.

If the cabinet must be opened for any reason:

1. Move genset operation switch or Stop/Auto/Handcrank switch (whichever applies) to Stop.
2. Disconnect genset batteries (negative [-] lead first).
3. Remove AC power to automatic transfer switch. If instructions require otherwise, use extreme caution due to shock hazard.

MEDIUM VOLTAGE GENERATOR SETS (601V TO 15kV)

- Medium voltage acts differently than low voltage. Special equipment and training are required to work on or around medium voltage equipment. Operation and maintenance must be done only by persons trained and qualified to work on such devices. Improper use or procedures will result in severe personal injury or death.
- Do not work on energized equipment. Unauthorized personnel must not be permitted near energized equipment. Induced voltage remains even after equipment is disconnected from the power source. Plan maintenance with authorized personnel so equipment can be de-energized and safely grounded.

GENERAL SAFETY PRECAUTIONS

- Do not work on equipment when mentally or physically fatigued or after consuming alcohol or drugs.
- Carefully follow all applicable local, state and federal codes.
- Never step on equipment (as when entering or leaving the engine compartment). It can stress and break unit components, possibly resulting in dangerous operating conditions from leaking fuel, leaking exhaust fumes, etc.
- Keep equipment and area clean. Oil, grease, dirt, or stowed gear can cause fire or damage equipment by restricting airflow.
- Equipment owners and operators are solely responsible for operating equipment safely. Contact your authorized Onan/Cummins dealer or distributor for more information.

KEEP THIS DOCUMENT NEAR EQUIPMENT FOR EASY REFERENCE.

Table of Contents

TITLE	PAGE
SAFETY PRECAUTIONS	Inside Front Cover
TABLE OF CONTENTS	1
INTRODUCTION	2
About This Manual	2
Generator Set	2
How to Obtain Service	2
SPECIFICATIONS	3 & 4
INSTALLATION	5
General	5
Location	5
Mounting	5
Ventilation	5
Cooling Systems	7
Exhaust Systems	8
Fuel Supply Systems	9
Electrical Connections	10
Preparing Set for Operation	14
Initial Starting and Checks	15
OPERATION	16
General	16
Pre-Start Checks	16
Control Panel	16
Optional Control Panel Equipment	18
Control Panel Interior	18
Starting Procedure	19
Stopping	19
Operating Recommendations	19
Out-of-Service Protection	20
Troubleshooting	20
MAINTENANCE	23
Set Inspection	23
Lubrication System	24
Crankcase Ventilation Tube	25
Fuel System	26
Batteries	27
Alternator and Fan Belt	27
Air Cleaner	27
Cooling System	27
AC Generator	29

WARNING

INCORRECT SERVICE OR REPLACEMENT OF PARTS MIGHT RESULT IN SEVERE PERSONAL INJURY AND/OR EQUIPMENT DAMAGE. SERVICE PERSONNEL MUST BE QUALIFIED TO PERFORM ELECTRICAL AND/OR MECHANICAL SERVICE.

Introduction

ABOUT THIS MANUAL

This manual provides general information for operating and maintaining your Onan generator set. Study this manual carefully and observe all warnings and cautions. Using the generator set properly and following a regular maintenance schedule will result in longer unit life, better performance, and safer operation.

GENERATOR SET

The generator set consists of an Onan generator driven by a John Deere engine. See the SPECIFICATIONS section for generator ratings. Refer to the John Deere operator's manual for more specific information about the engine.

HOW TO OBTAIN SERVICE

When the generator set requires servicing, contact an Onan distributor for assistance. Onan's factory-trained parts and service representatives are ready to handle all your service needs.

When contacting an Onan distributor, always supply the complete model number and serial number as shown on the Onan nameplate. The Onan nameplate is located on the side of the generator control box.

A separate identification nameplate is attached to the engine by the engine manufacturer. When requesting parts or service for the engine, always provide the engine manufacturer's model number, serial number, etc., to avoid confusion.

Model

Serial No.

McGraw-Edison

Onan GenSet

Model No.

Serial No.

Important - Give above no.'s when ordering parts

Service Rating:

Hertz:RPM:

Single PhasekW KVA

Three PhasekW KVA

Volts: 110/190 110/220 115/200 115/230 120/208

Amps: 120/240 127/220 139/240 220/380 230/400 240/416

240/480 254/440 277/480 347/600 115/230 10 120/240 10

For ElecEqpt OnlyPF: Bat.:

Insul - NEMA Class F Amb 40°C

Onan Corporation Minneapolis Mn 55432 USA

Made in USA

M-1378

Onan Nameplate

Specifications - DDA

GENERATOR DETAILS

Type Onan, Revolving Field, 4-Pole, Brushless
Rating
 60 Hertz Continuous Standby 30 kW (37.5 kVA at 0.8 PF)
 50 Hertz Continuous Standby 25 kW (31.2 kVA at 0.8 PF)
AC Voltage Regulation $\pm 2\%$

ENGINE DETAILS

Engine John Deere 300-4219
Engine Speed (r/min)
 50 Hertz Operation 1500
 60 Hertz Operation 1800
Fuel ASTM No. 2 Diesel
Fuel Pump Inlet Size 1/8-27 NPTF INTL
Fuel Return Outlet 0.25-in. (6 mm) O.D. Tube
Fuel Pump Maximum Lift 8 ft. (2.4 m)
Exhaust Outlet (Pipe Tapped) 2-in. NPT INTL
Starting System Voltage 12
Battery Requirements
 BCI Group Size 2H
 Cold Cranking Amps @ 0°F (-18°C) 565
 Amp Hour Capacity 135 (486 kC)
 Battery Voltage 6
 Quantity Required 2
Cooling System (Engine and Radiator) 17 quarts (16 litres)
Engine Oil Capacity (Filter, Lines, and Crankcase) 9 quarts (8.5 litres)

Specifications - DDB

GENERATOR DETAILS

Type Onan, Revolving Field, 4-Pole, Brushless
Rating
 60 Hertz Continuous Standby 50 kW (62.5 kVA at 0.8 PF)
 50 Hertz Continuous Standby 40 kW (50 kVA at 0.8 PF)
AC Voltage Regulation $\pm 2\%$

ENGINE DETAILS

Engine John Deere 300-6329
Engine Speed (r/min)
 50 Hertz Operation 1500
 60 Hertz Operation 1800
Fuel ASTM No. 2 Diesel
Fuel Pump Inlet Size 1/8-27 NPTF INTL
Fuel Return Outlet Size 0.25-in. (6 mm) O.D. Tube
Fuel Pump Maximum Lift 8 ft. (2.4 m)
Exhaust Outlet (Pipe Tapped) 2.5-in. NPT INTL
Starting System Voltage 12
Battery Requirements
 BCI Group Size 2H
 Cold Cranking Amps @ 0°F (-18°C) 565
 Amp Hour Capacity 135 (486 kC)
 Battery Voltage 6
 Quantity Required 2
Cooling System (Engine and Radiator) 20 quarts (18.9 litres)
Engine Oil Capacity (Filter, Lines, and Crankcase) 12 quarts (11.4 litres)

Installation

GENERAL

Installations must be considered individually. Use these instructions as a general guide. Meet regulations of local building codes, fire ordinances, etc., which may affect installation details. See Figure 1.

Installation points to consider include:

1. Level mounting surface.
2. Adequate cooling air.
3. Adequate fresh induction air.
4. Discharge of circulated air.
5. Discharge of exhaust gases.
6. Electrical connections.
7. Fuel connections.
8. Water connections.
9. Accessibility for operation and servicing.
10. Vibration isolation.
11. Noise levels.

LOCATION

Provide a location that is protected from the weather and is dry, clean, dust free and well ventilated. If practical, install inside a heated building for protection from extremes in weather conditions.

MOUNTING

These generator sets have built-in vibration isolators and normally require no extra isolation. For critical installations, however, you can install vibration isolators between skid base and foundation. Onan has two types of vibration isolators available. One is a cork and rubber pad type which performs satisfactorily for most installations. The other is an adjustable spring-type which can be used for critical locations. The Onan DDA and DDB generator sets require four vibration isolators.

For convenience in draining engine oil and general servicing, mount the generator set on a raised concrete pedestal at least 6 inches (152 mm) high. If mounting in a trailer or in any type of mobile application, bolt securely in place and make sure the vehicle flooring provides enough support.

VENTILATION

Generator sets create considerable heat which must be removed by proper ventilation. Outdoor installations rely on natural air circulation but indoor installations need properly sized and positioned vents for the required airflow.

Vents and Ducts

Locate vents so cool, incoming air passes through the immediate area of the installation before exhausting. Install the air outlet higher than the air inlet to allow for convection air movement. See Figure 1.

Size the vents and ducts so they are large enough to allow the required flow rate of air. "Free area" of louvers, screens and ducts must be as large as the radiator area (when radiator is used). The inlet air vent should be 1-1/2 times the size of the radiator outlet vent.

Cooling air travels from the rear of Onan generator sets to the front (engine end).

Wind will restrict free airflow if it blows directly into the air outlet vent. Consider prevailing wind directions when planning vent locations.

Dampers

Dampers can be used in any system to block the airflow through the vents when the generator set is not running. This is sometimes necessary in cold climates to keep the generator enclosure at a normal temperature. Refer to Onan Technical Bulletin T-030 for more detailed information.

Radiator Set Ventilation Requirements

Radiator set cooling air is drawn past the rear of the set by a fan which blows air through the radiator. Locate the air inlet to the rear of set and near the floor. Make the inlet vent opening 1-1/2 times larger than the radiator.

Locate the cooling air outlet directly in front of the radiator and as close as possible. The effective opening area should be 1.3 times as large as the radiator area. Length and shape of the air outlet duct should offer minimum restriction to airflow. Use a duct of canvas or sheet metal between the radiator and the air outlet opening to prevent recirculation of heated air.

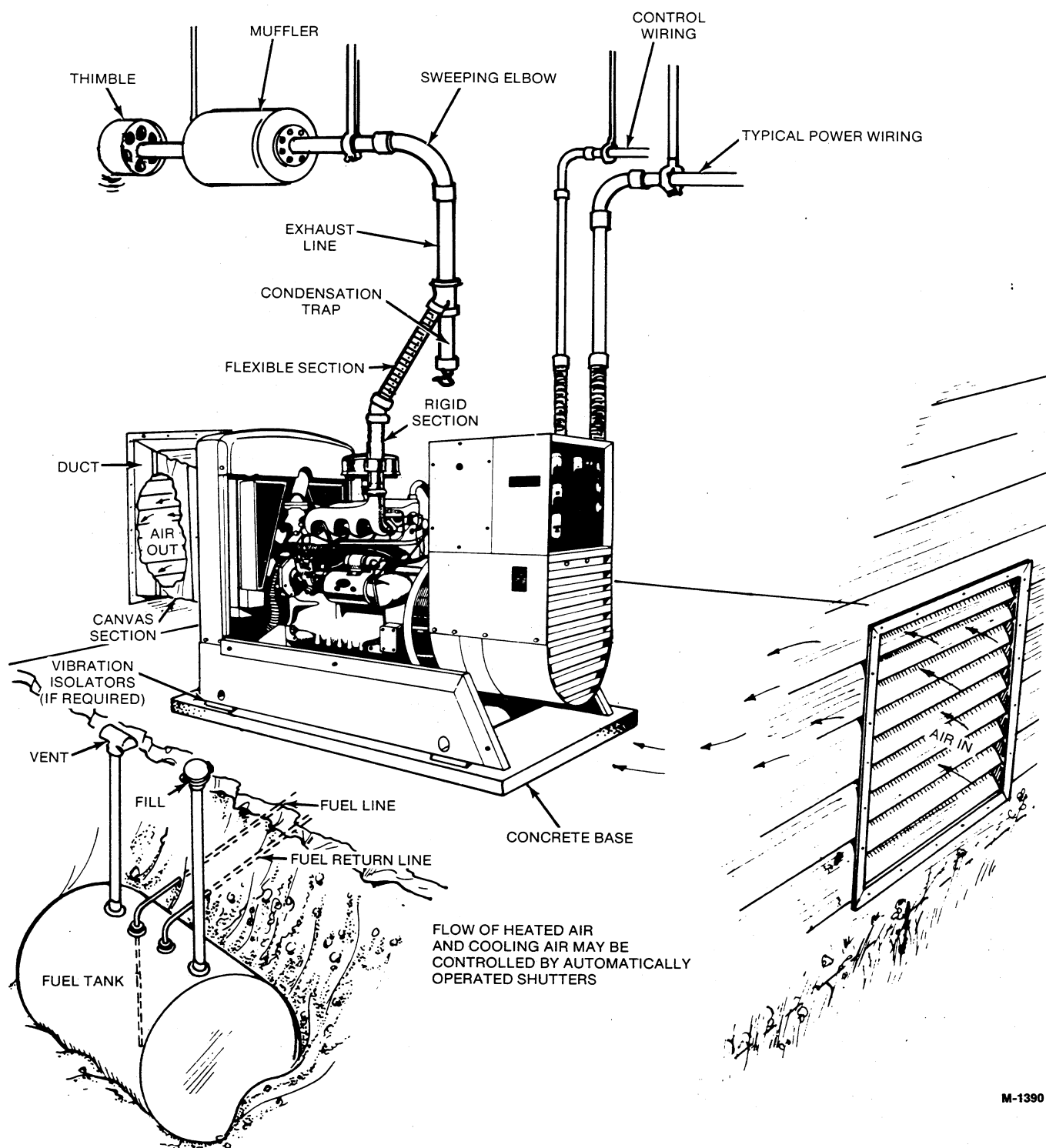


FIGURE 1. TYPICAL INSTALLATION

City Water Set Ventilation Requirements

City water cooled sets do not use a conventional radiator. Instead, a constantly changing water flow cools the engine. Sufficient air movement and fresh air must be available to cool the generator, disperse heat radiated from the engine, and to support combustion. Additional information is contained in Technical Bulletin T-030.

To provide sufficient airflow, ventilation fans might be required. Size the fans to remove all heat rejected to the room by the generator set, exhaust pipes, and other heat producing equipment. Maintaining a temperature differential of 20° to 30°F (11° to 17°C) is usually satisfactory.

COOLING SYSTEMS

A set mounted radiator with engine driven fan is standard on the generator set. Optional cooling systems include remote radiator cooling for both DDA and DDB model generator sets. City water cooling with standpipe and city water cooling with heat exchanger are available only with the DDA generator sets. The following sections briefly cover the installation requirements for each system. Refer to Technical Bulletin T-030 for more detailed information.

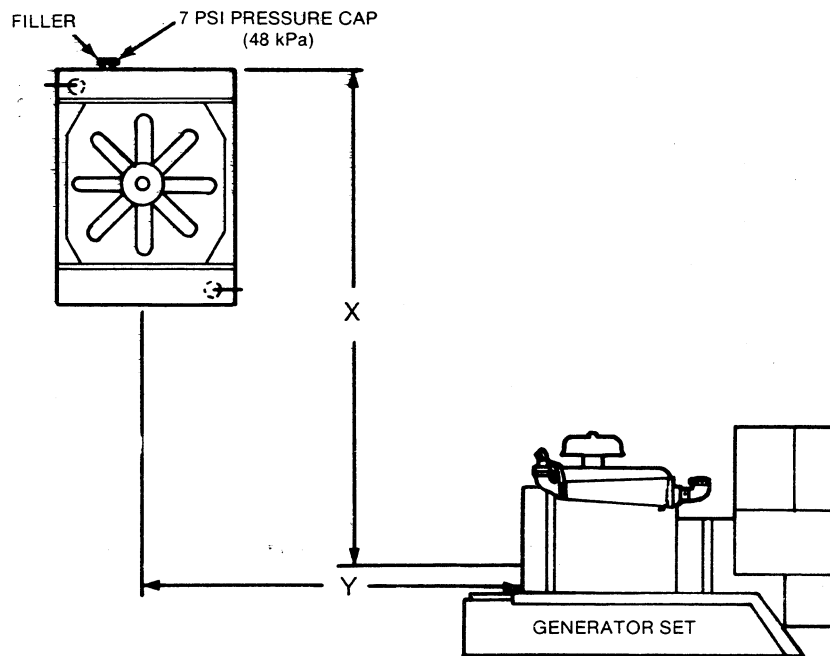
Radiator Cooling (Standard)

The standard radiator cooling system (see Figure 1) uses a set mounted radiator with an engine driven pusher type fan to cool the generator set. Air is pulled from the generator end of the set across the engine and then forced through the radiator. An air duct adapter flange surrounds the radiator grill to allow mounting of the air discharge duct. Refer to the section on Ventilation for location and sizing of ducts and vents.

Remote Radiator (Optional)

Remote radiator cooling systems use a remote mounted radiator with electrically driven fans for generator set cooling. Removal of the radiator and fan from the set reduces the set enclosure ventilation requirements to the level of city water cooled sets, without making the unit dependent on a continuous water supply. The remote radiator system can also be completely protected against freezing.

The two key design considerations in a remote radiator installation are the vertical distance (X) from the engine centerline to the radiator top and the horizontal distance (Y) from the engine front to the radiator centerline (see Figure 2). These distances determine if any additional equipment is required such as a surge tank, auxiliary pump, or hot well. Because of the many design considerations, all remote radiator installations must be engineered to insure that the system will function properly. Follow the instructions of the consulting engineer when installing a remote radiator system. Additional information is contained in Technical Bulletin T-030.



CS-1194

FIGURE 2. REMOTE RADIATOR INSTALLATION

City Water Cooling (available for DDA only)

City water cooling systems use either a standpipe or a heat exchanger for cooling the generator set. Both systems are dependent on an uninterruptible supply of cool water.

Heat Exchanger: This system uses a shell and tube type heat exchanger instead of the standard radiator and fan. Engine coolant circulates through the shell side of the heat exchanger while raw cooling water is pumped through the tubes. Engine coolant and raw water do not mix.

A heat exchanger system reduces set enclosure airflow and noise levels. Proper operation depends upon a constant supply of raw water for heat removal. The engine coolant side of the system may be protected from freezing. The raw water side cannot be protected from freezing. See Figure 3 for a schematic of a heat exchanger system.

Standpipe: This system uses a mixing (tempering) tank for the standard radiator and fan. Cooling water circulating through the engine jacket is mixed with raw water in the tank. Because raw water flows through the engine jacket, it must not contain scale forming impurities or fouling of the engine water will occur.

Standpipe cooling reduces set enclosure airflow requirements and noise levels. Proper operation is dependent on a constant supply of cooling water. The system cannot be protected from freezing. See Figure 4 for a schematic of a standpipe system.

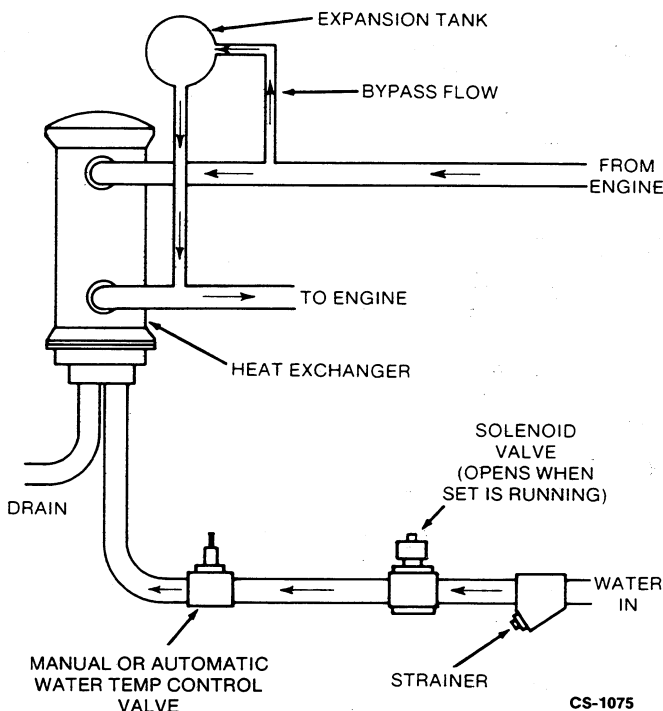


FIGURE 3. HEAT EXCHANGER

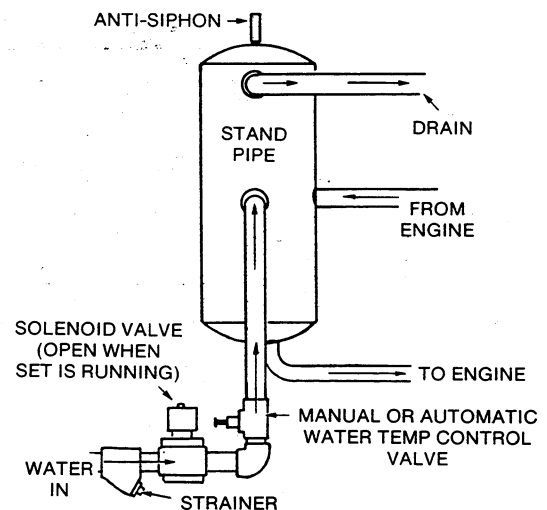
Cooling Connections: All heat exchanger and standpipe cooled sets must be connected to a pressurized supply of cold water. Make connections to the set with cold water flexible pipe to absorb vibration. On the cool water line, install a solenoid valve to shut off the flow when the set is shut down and a rate of flow valve to control engine temperature. This valve can be either manual or automatic. Actual rate of flow depends on inlet water temperature.

Before filling cooling system, check all hardware for tightness. This includes hose clamps, capscrews, fittings and connections. Use flexible coolant lines with heat exchanger, standpipe or remote mounted radiator. Adjust the valve to maintain water outlet temperature between 165° to 195° F (74° to 90° C) while operating the unit at full load.

EXHAUST SYSTEMS

Pipe exhaust gases to the outside of any enclosure. Locate the exhaust outlet away from any air inlets to avoid exhaust gases re-entering the enclosure. Exhaust installations are subject to various detrimental conditions such as extreme heat, infrequent operation, light loads, etc.

WARNING *Inhalation of exhaust gases might result in serious personal injury or death. Use extreme care during installation to ensure a tight exhaust system.*



CS-1096

FIGURE 4. STANDPIPE

Use an approved thimble (see Figure 5) where exhaust pipes pass through walls or partitions. Build the thimble according to code requirements (see National Fire Protection Association bulletin, Volume 4, section 211, covering "Standards for Chimneys, Fireplaces, and Vents").

WARNING *Inhalation of exhaust gases might result in serious personal injury or death. Do not use exhaust heat to warm a room, compartment or storage area.*

Pitch a horizontal run of exhaust pipe downward to allow any moisture condensation to drain away from the engine. If an exhaust pipe must be turned upward, install a condensation trap at the point where the rise begins (see Figure 6).

Use large radius elbows and provide adequate support for mufflers and piping. Use a section of flexible stainless steel tubing between the engine exhaust connection and the exhaust piping system to permit movement and thermal expansion. Shield or insulate exhaust lines if there is danger of personal contact. Allow at least 12 inches (305 mm) of clearance if the pipes pass close to a combustible wall or partition.

CAUTION *Weight applied to the engine manifold might result in manifold damage. Support the muffler and exhaust piping so that no weight or stress is applied to the engine exhaust manifold.*

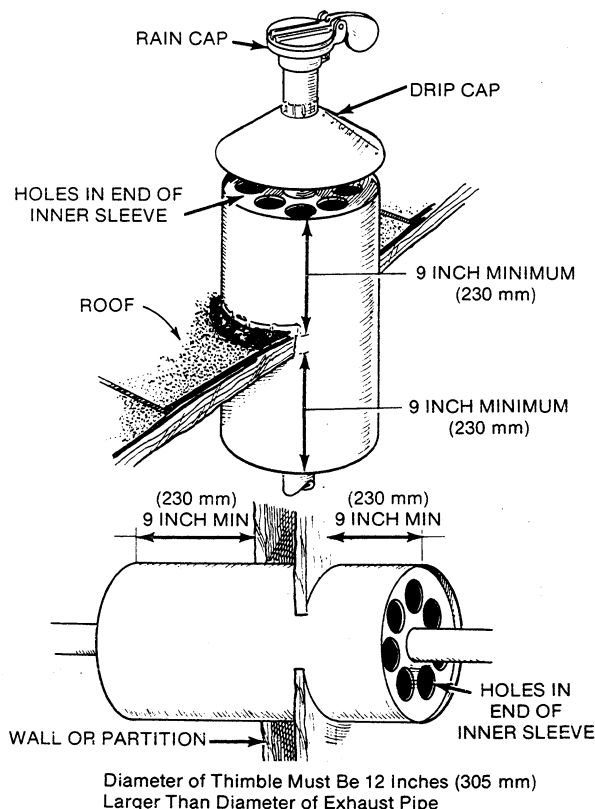
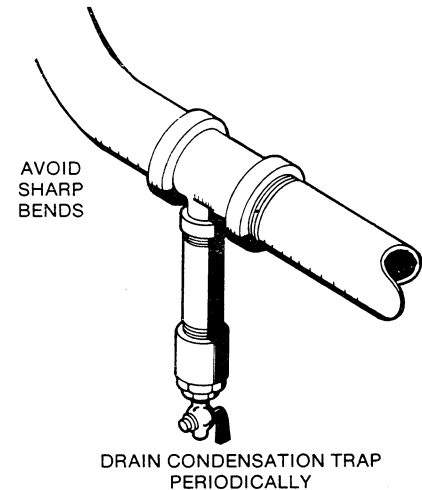


FIGURE 5. EXHAUST THIMBLE

EXS-1036

IF EXHAUST LINE MUST BE PITCHED UPWARD, CONSTRUCT A TRAP OF PIPE FITTINGS AT POINT OF RISE



EXS-1046

FIGURE 6. EXHAUST CONDENSATION TRAP

Refer to Technical Bulletin T-030 for the recommended maximum equivalent exhaust pipe length. The total exhaust system equivalent length includes the exhaust pipe, all fittings, and the muffler. Exceeding the recommended maximum length will create excessive back pressure in the system.

FUEL SUPPLY SYSTEMS

Check local regulations governing installation of fuel tanks before installing the fuel supply system.

General

In all fuel system installations, cleanliness is of the utmost importance. Make every effort to prevent entrance of moisture, dirt or contaminants of any kind. Clean all fuel system components before installing.

Use only compatible metal fuel lines to avoid electrolysis when fuel lines must be buried. Onan can supply copper fuel lines with brass fittings if required. Never use galvanized fuel lines or fittings with diesel fuel as it tends to flake off and contaminate the fuel. Use a flexible section of tubing between the engine and fuel supply line to withstand vibration.

CAUTION *Never use galvanized fuel lines, fittings or fuel tanks with diesel fuel systems. Condensation in the tank and lines combines with the sulfur in diesel fuel to produce sulfuric acid. The zinc coating on galvanized lines or tanks reacts with the acid and flakes off to contaminate the fuel.*

An electric solenoid shutoff valve in the supply line is always desirable and required for indoor automatic or remote starting installations. Connect the solenoid wires to the battery ignition circuit to open the valve during generator set operation.

Supply Tank

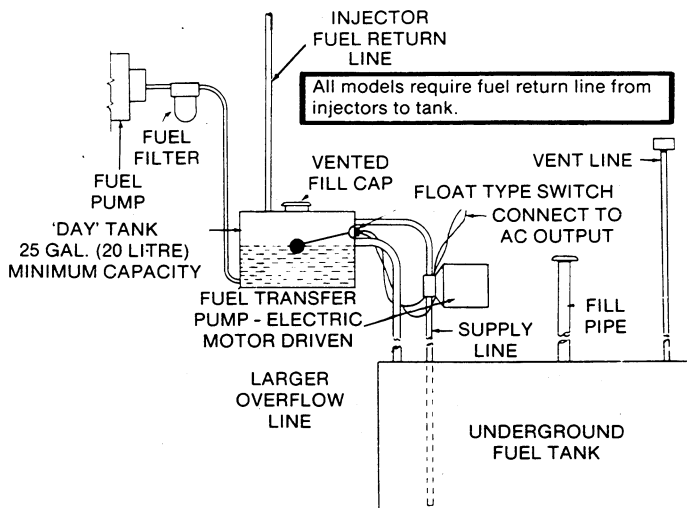
Locate the fuel tank as close as possible to the generator set and within the 8-foot (2.4 metre) lift capacity of the fuel pump if possible. Choose a tank that has sufficient capacity to keep the generator running continuously at full load for at least 36 hours. Onan can supply underground fuel tanks from 55 to 560 gallons (208 to 2120 litres) in capacity.

WARNING *Fuel leaks create fire and explosion hazards which might result in severe personal injury or death. Always use flexible tubing between engine and the fuel supply to avoid line failure and leaks due to vibration. The fuel system must meet applicable codes.*

A typical underground fuel system consists of a main fuel tank, vent and fill pipes, fuel supply line, and fuel return line (see Figure 1). If the tank is installed below the lift capabilities of the standard fuel transfer pump, a day tank and auxiliary pump will also be required. If an overhead tank is installed, a day tank and float valve will be required to prevent fuel head pressures from being placed on the fuel system components. Refer to Technical Bulletin T-030 for examples of fuel supply systems that require a day tank.

Day Tank (If Used)

Day tanks are fuel transfer tanks which are used when the standard engine fuel pump does not have the capacity to draw the fuel from the supply tank; or the supply tank is overhead and presents problems of high fuel head pressure for the fuel return. See Figure 7.



ES-1214

FIGURE 7. DAY TANK (TYPICAL)

WARNING

Fuel presents the hazard of fire or explosion which might result in severe personal injury or death. Provide an overflow line to the supply tank from the day tank. This prevents fuel spills from the day tank if a float valve switch malfunction occurs.

Supply Tank Lower Than Engine: With this installation, the day tank is installed near the generator set and within the engine fuel pump lift capability, but below the fuel injection system. Install an auxiliary fuel pump as close as possible to the supply tank to pump fuel from the supply tank to the day tank. A float switch in the day tank controls operation of the auxiliary fuel pump.

The supply tank top must be below the day tank top to prevent siphoning from the fuel supply tank to the day tank.

Provide a return line from the engine injection system return connection to the day tank (near the top). Also provide a day tank overflow line to the supply tank in case the float switch fails to shut off the fuel transfer pump.

Supply Tank Above Engine: Install the day tank near the generator set and within the engine fuel pump lift capability, but below the fuel injection system. Use fuel line at least as large as the fuel pump inlet. The engine fuel return line must enter the day tank.

Include a shutoff solenoid in the fuel line between the fuel supply tank and the day tank. It stops fuel flow when the generator set is shut down.

Engine Fuel Connections

Identification tags are attached to the fuel supply line and fuel return line connections by the factory. Flexible lines for connecting between the engine and the stationary fuel line are supplied as standard equipment. Refer to the SPECIFICATIONS section for the fitting sizes.

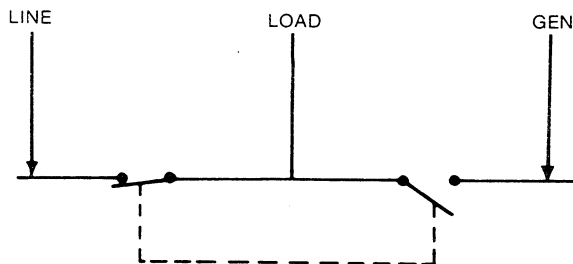
ELECTRICAL CONNECTIONS

General

Installing the generator set electrical system includes connecting the load and switchgear, installing the remote start control (if used), and connecting the batteries. The batteries should always be connected last to avoid accidental starting of the unit during installation.

Most local regulations require that wiring connections be made by a licensed electrician and that the installation be inspected and approved before operation. All connections, wire sizes, etc., must conform to the requirements of all electrical codes in effect at the installation site.

If the installation is for standby service, a double throw transfer switch must always be used (see Figure 8). Instructions for connecting an automatic load transfer control are included with such equipment.



NOTE: SHOWN WITH LINE CONNECTED TO LOAD

FIGURE 8. LOAD TRANSFER SWITCH

SC-1101

Generator Voltage Connections

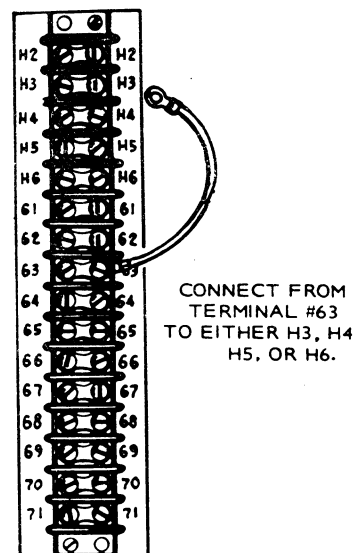
The generator output voltage and maximum current rating is specified on the generator nameplate. Line-to-neutral voltage is always the lower voltage shown on the nameplate and line-to-line voltage is the higher rating.

Generators can be divided into two groups: reconnectible and non-reconnectible. The reconnectible type generator can be wired to give one of several possible voltages. Non-reconnectible type generators produce only specific voltage and cannot be wired to give a different voltage without extensive modifications. The following sections explain the connection procedure for each type of generator.

Reconnectible Generators (Voltage Codes 15R and 515R): Generators with these codes can be reconnected for the voltages shown in the chart of Figure 11. The installer must check the voltage reference transformer lead connection and then, if necessary, reconnect it to the appropriate terminal; and connect the appropriate generator leads together.

Voltage Reference Transformer Lead: Open the hinged control panel doors of the generator set. Connect the lead from terminal TB21-63 to the correct terminal for the voltage selected as designated in the chart of Figure 11 (terminal H3, H4, H5, or H6). Also see Figure 9.

Generator Leads: Reconnectible generators are shipped with their twelve leads not connected together in the control box. Remove the right, left, or top panel from the control box. Then connect the wires together according to Figure 11 for the voltage selected. Proceed to **LOAD CONNECTIONS**.

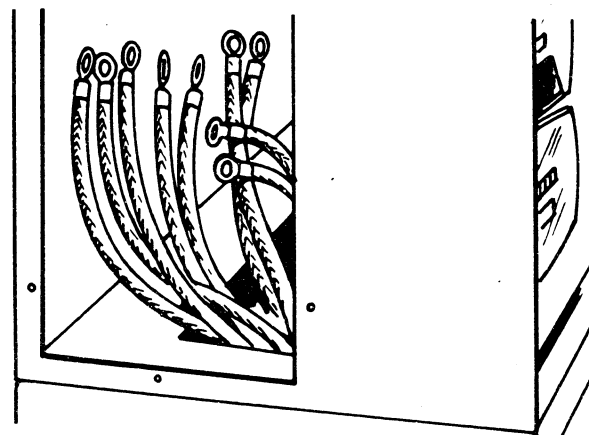


ES-1303

FIGURE 9. CONNECTING LEAD FROM TERMINAL 63

You can temporarily connect these leads together until the load wires are brought into the control box area and bolted to the generator leads; or, you can perform the load connections at the same time as connecting the generator leads together.

Non-reconnectible Generators (Voltage Codes 3R, 6DR, 7R, and 9XR): These generators are assembled for specific voltages and are not intended for reconnection. Remove the left, right, or top panel from the control box (Figure 10) and proceed to **LOAD CONNECTIONS**.



ES-1304

FIGURE 10. CONTROL BOX (SIDE PANEL REMOVED)

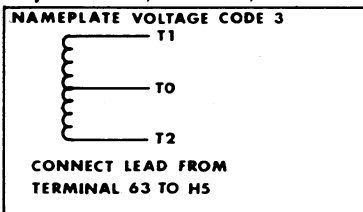
SEE
NOTE

NAMEPLATE VOLTAGE CODE	VOLTAGE	PHASES	HERTZ	CONNECT LEAD FROM TERMINAL 63 TO:	GENERATOR CONNECTION	GENERATOR CONNECTION SCHEMATIC DIAGRAM	GENERATOR CONNECTION WIRING DIAGRAM (WITH CURRENT TRANSFORMERS WHEN USED)
15	120/240	1	60	H5	DOUBLE DELTA		
515	115/230 110/220	1	50	H6	DOUBLE DELTA		
6D	240/480	3	60	H5	SERIES DELTA		
15	120/240	3	60	H5	SERIES DELTA		
515	115/230 110/220	3	50	H6	SERIES DELTA		
15	120/208 127/220 139/240	3	60	H3	PARALLEL WYE		
515	110/190 115/200 120/208 127/220	3	50	H3	PARALLEL WYE		
15	240/416 254/440 277/480	3	60	H3	SERIES WYE		
515	220/380 230/400 240/416 254/440	3	50	H3	SERIES WYE		
7	220/380	3	60	H3	SERIES WYE		

98C2193

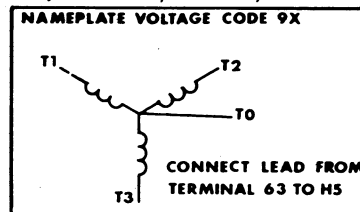
3R

120/240 VOLT, 1 PHASE, 60 HERTZ



9XR

347/600 VOLT, 3 PHASE, 60 HERTZ



NON-RECONNECTIBLE GENERATORS

NOTE: AVAILABLE SINGLE-PHASE POWER IS 2/3 OF 3-PHASE KVA
VOLTAGE CODE 15 OR 515 GENERATOR.

FIGURE 11. VOLTAGE CONNECTIONS

ES-1305

Load Connections

Load Balancing: When connecting loads to the generator set, balance the loads so that the current flow from each line terminal (L1, L2, and L3) is about the same. This is especially important if both single phase and three phase loads are connected. Any combination of single phase and three phase loading can be used as long as each line current is about the same, within 10 percent of median value, and no line current exceeds the nameplate rating of the generator. Check the current flow from each line after connections (procedure following) by observing the control panel ammeter.

Connecting the Load: All loads are connected to the generator by bolting the load wires to the appropriate generator leads in the control box as indicated in Figure 11. Insulate the connections. Use a section of flexible conduit at the control box to permit movement.

Grounding

Grounding involves making a conducting connection between the metal parts of the generator set or one of its electrical circuits and the earth. The design and installation of a grounding system is affected by many factors such as use of multiple transformers, ground fault protection requirements, and physical location of the generator. Follow the recommendations of the consulting engineer when installing the grounding system.

WARNING *Contact with electrically "hot" equipment might result in severe personal injury or death. It is extremely important that bonding and equipment grounding be properly done. All metallic parts which could become energized under abnormal conditions must be properly grounded.*

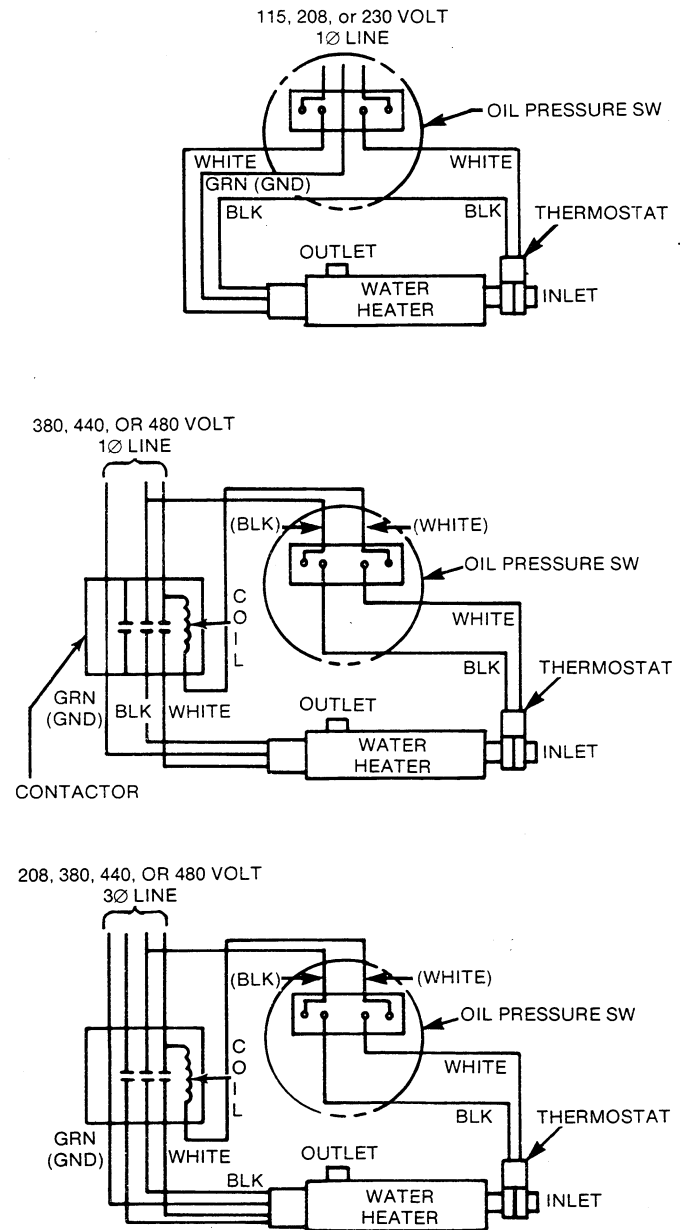
Typical requirements for bonding and grounding are given in the National Electrical Code, NFPA No. 70, Article 250. All connections, wire sizes, etc. must conform to the requirements of the electrical codes in effect at the installation site.

Coolant Heater (Optional)

A coolant heater can be installed to keep engine coolant warm while the engine is shut down. It heats and circulates the coolant within the engine which reduces start-up time and engine wear caused by cold starts. It is electrically operated and thermostatically controlled.

CAUTION *The heater must not be operated while the cooling system is empty or when the engine is running or damage to the heater will occur.*

Figure 12 shows the heater connections. Connect the heater to a source of power that will be on during the time the engine is not running. Be sure the voltage rating is correct for the heater element rating.

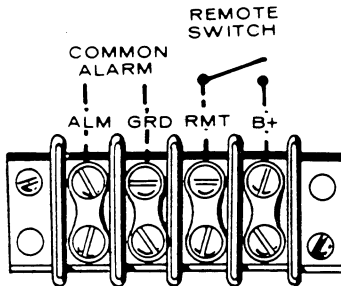


CS-1195

FIGURE 12. COOLANT HEATER WIRING DIAGRAMS

Remote Control Connections

Provision is made for addition of remote starting. This is accomplished with a four-place terminal block located within the control box. Connect one or more remote switches across remote terminal and B+ terminal as shown in Figure 13. If the distance between the set and remote station is less than 1000 feet (305 m), use No. 18 AWG wire; between 100 and 2000 feet (31 and 610 m), use No. 16 AWG wire.



ES-1308

FIGURE 13. REMOTE CONTROL TB12

PREPARING GENERATOR SET FOR OPERATION

Before attempting the initial start of the generator set, be sure it is serviced for operation. Refer to the engine manufacturer's manual and to the MAINTENANCE section of this manual for the proper procedures. Service the following.

Lubrication

Engine oil was drained prior to shipment. Before starting, fill the crankcase with the recommended oil and prime the lubrication system.

Coolant

Engine coolant was drained prior to shipment. Before starting, fill the cooling system with recommended coolant.

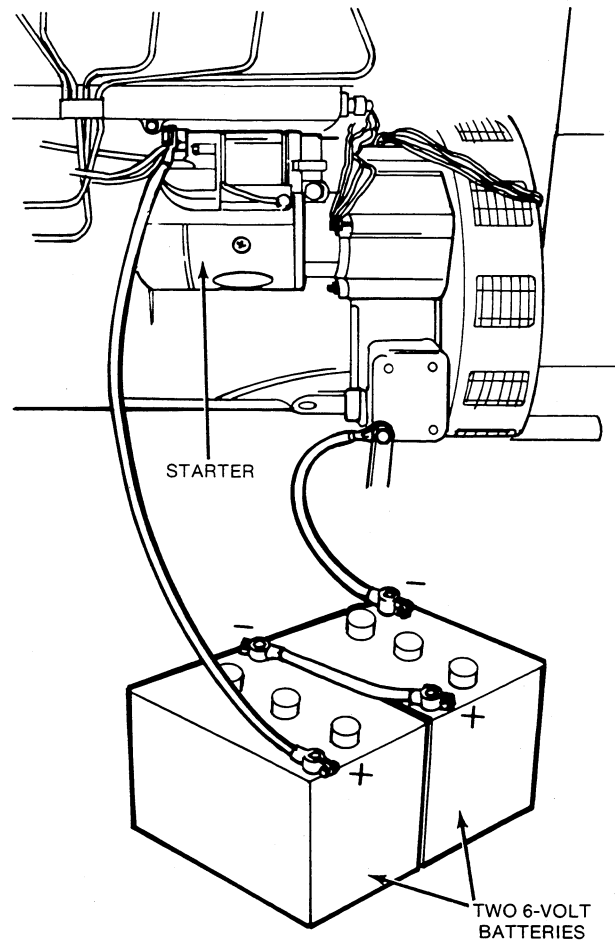
Fuel

Fill the fuel tanks with the recommended fuel and prime the fuel system.

Connect Starting Batteries

Starting the unit requires 12-volt battery current. Use two 6-volt (see *SPECIFICATIONS*) batteries for a normal installation. Connect the batteries in series (negative post of first battery to positive post of second) as in Figure 14. Necessary battery cables are included. Service the batteries as necessary. Infrequent unit use (as in emergency standby service) can allow the batteries to self-discharge to the point where they cannot start the unit. If installing an automatic transfer switch and it has no built-in charge circuit, connect a special float charger to keep the battery charged at proper levels.

WARNING Ignition of explosive battery gases might cause severe personal injury. Do not smoke while servicing batteries.



ES-1301

FIGURE 14. STARTING BATTERY CONNECTIONS

INITIAL STARTING AND CHECKS

Before putting the generator set under load conditions, perform the following to verify the generator set will perform correctly.

1. Start the generator set. Move the Run-Stop-Remote switch on the engine control panel to the RUN position. The starter should crank the engine, and the engine should start within a few seconds.
2. Monitor the engine control panel and note the oil pressure, coolant temperature, and battery charge rate. Refer to the OPERATION section of this manual for normal readings. With the engine at operating temperature, all readings should stay within the normal range.
3. Check the generator set for fuel, oil or coolant leaks. If you find any leaks, move the Run-Stop-Remote switch to STOP. Have the leak repaired before performing the rest of the checks.
4. Check the exhaust system for leaks, visually and audibly. Note the security of the exhaust system supports. If you find any leaks, shut down the generator set immediately by moving the Run-Stop-Remote switch to STOP.

WARNING

Exhaust gas is deadly. For this reason, shut down the generator set immediately if you discover an exhaust leak or exhaust component needing replacement. Do not use the generator set until you have the exhaust system repaired.

5. Note the AC instruments of the engine control panel (if equipped). The frequency meter and voltmeter should indicate rated nameplate frequency and voltage. Use the phase selector switch to read each of the line-to-line voltages. If other than the nameplate ratings, see the TROUBLESHOOTING tables in the OPERATION section.
6. Stop the generator set by moving the Run-Stop-Remote switch to STOP. See the OPERATION section.

Operation

GENERAL

This section covers starting and operating the generator set. It is recommended that the operator read through this entire section before attempting to start the set. It is essential that the operator be completely familiar with the set to insure safe operation.

PRESTART CHECKS

Before starting, be sure the following checks have been made and the unit is ready for operation. Refer to the *MAINTENANCE* section for the proper procedures.

Lubrication

Check the engine oil level. Keep the oil as near as possible to the full mark.

Coolant

The coolant level should come up to the bottom of the fill tube which is recessed into header tank of the radiator. Do not check while the coolant is hot.

WARNING

Contact with hot coolant might result in serious burns. Do not bleed hot, pressurized coolant from a closed cooling system.

Fuel

Make sure the fuel tanks have sufficient fuel. See the *MAINTENANCE* section for recommended fuel.

WARNING

Spilled fuel might ignite and cause serious personal injury or death. Never fill the fuel tank when the engine is running.

CONTROL PANEL

The following describes the function and operation of the standard generator set control. All instruments and control switches are located on the face of the control panel as illustrated in Figure 15. The control panel is separated into a DC panel for monitoring the engine and an AC panel for monitoring the generator.

DC Panel

Panel Light and Switch: Illuminates control panel.

Oil Pressure Gauge: Indicates pressure of lubricating oil in engine (wired to a sensor unit located on the engine).

Water Temperature Gauge: Indicates temperature of circulating coolant in engine (wired to a sensor unit located on the engine).

Battery Charge Rate DC Ammeter: Indicates the battery charging current.

Run-Stop/Reset-Remote Switch: Starts and stops the generator set at the unit and permits starting and stopping from a remote location.

Fault Lamp: Indicates fault in engine operation.

WARNING

EXHAUST GAS IS DEADLY!

Exhaust gases contain carbon monoxide, a poisonous gas that might cause unconsciousness and death. It is an odorless and colorless gas formed during combustion of hydrocarbon fuels. Symptoms of carbon monoxide poisoning are:

- Dizziness
- Headache
- Weakness and Sleepiness
- Vomiting
- Muscular Twitching
- Throbbing in Temples

If you experience any of these symptoms, get out into fresh air immediately, shut down the unit and do not use until it has been inspected.

The best protection against carbon monoxide inhalation is proper installation and regular, frequent inspections of the complete exhaust system. If you notice a change in the sound or appearance of exhaust system, shut the unit down immediately and have it inspected and repaired at once by a competent mechanic.

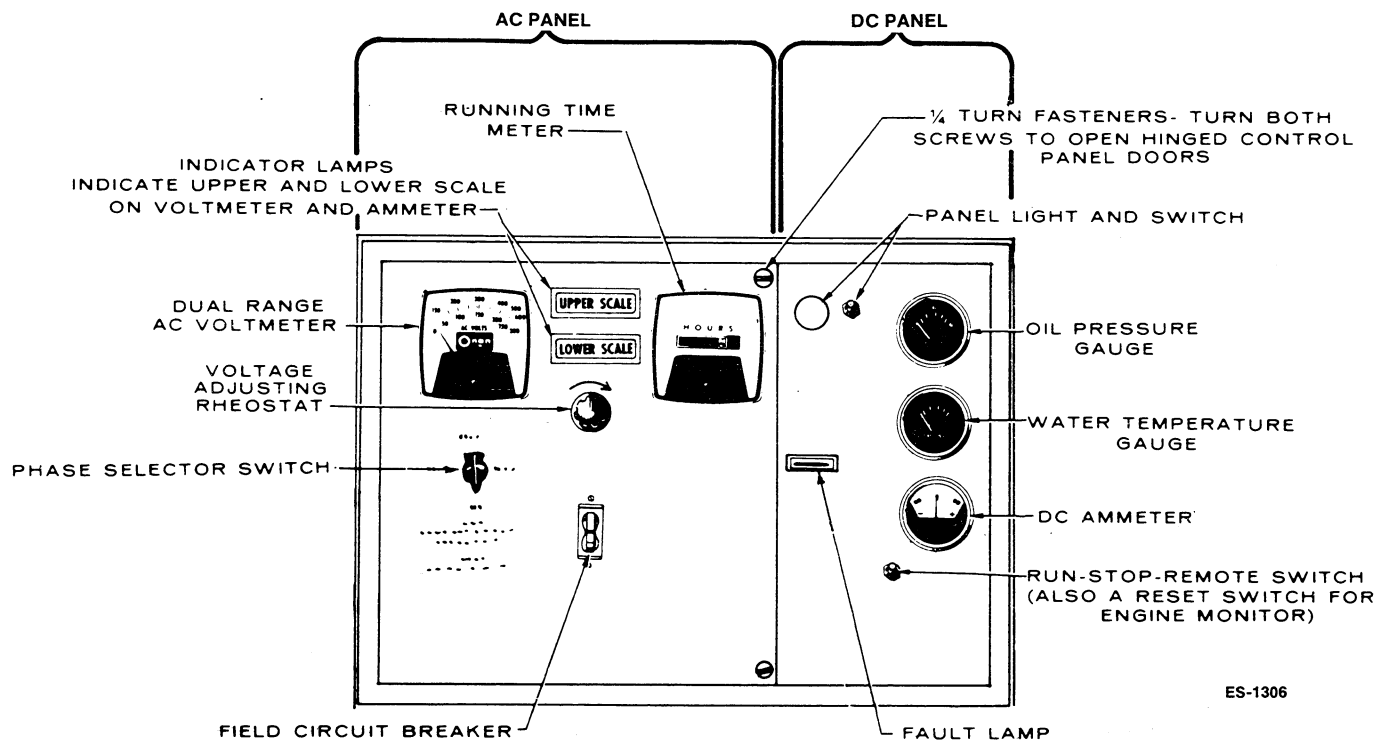


FIGURE 15. TYPICAL CONTROL PANEL (ONE-FAULT LAMP)

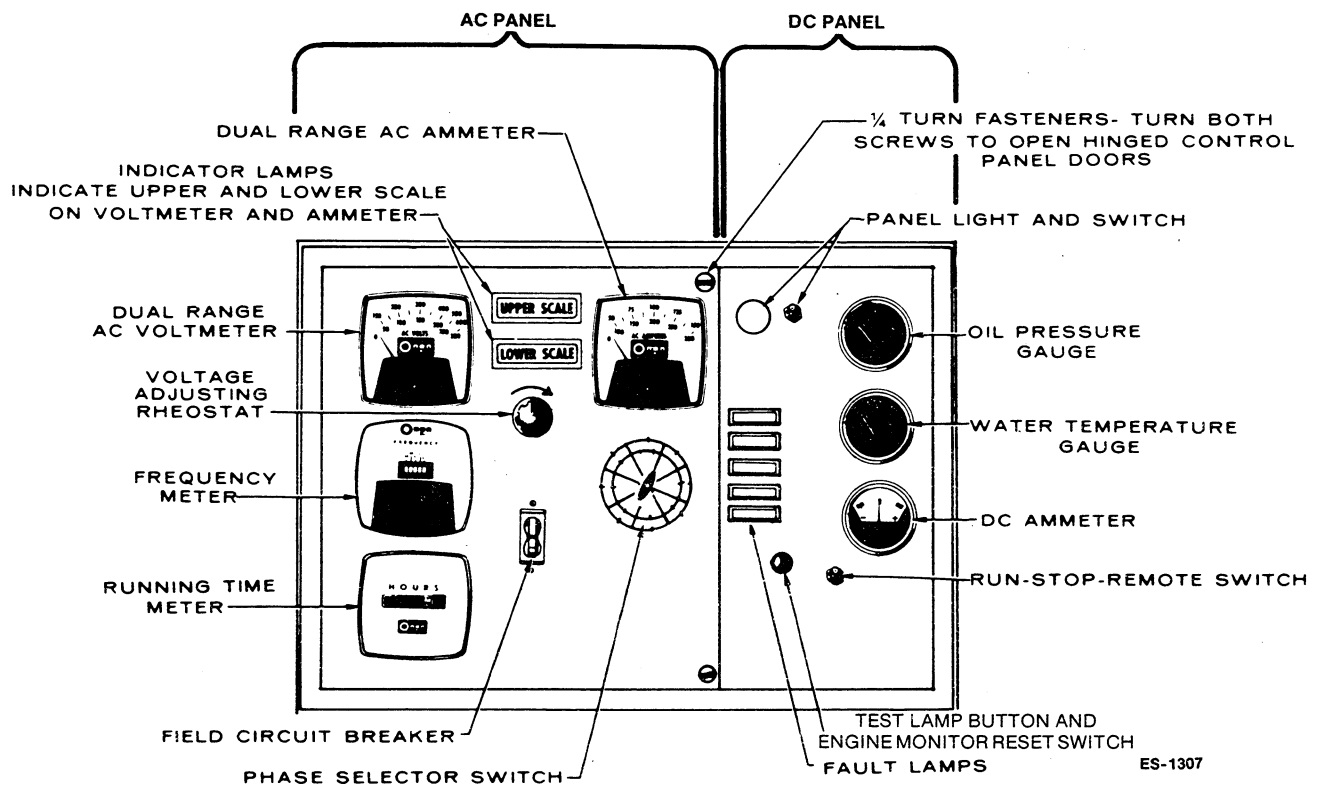


FIGURE 16. OPTIONAL CONTROL PANEL (FIVE-FAULT LAMPS)

AC Panel

AC Voltmeter: Indicates AC generator output voltage. Instrument is dual range (measurement range in use shown on indicator light).

Voltmeter Phase Selector Switch: Selects phases of generator output to be measured by AC voltmeter.

Voltage Regulator: Rheostat, provides approximately plus or minus five percent adjustment of the rated output voltage.

Exciter Circuit Breaker: Provides generator exciter and regulator protection from overheating in the event of certain failure modes of the generator, exciter and voltage regulator.

Running Time Meter: Registers the total number of hours the unit has run. Use it to keep a record for periodic servicing. Time is cumulative, and the meter cannot be reset.

OPTIONAL CONTROL PANEL EQUIPMENT

DC Panel

Fault Lamps: Eliminates the one fault lamp and substitutes five indicator lamps to give warning of —

- A. Overcrank (failed to start)
- B. Overspeed
- C. Low oil pressure
- D. High engine temperature
- E. Low engine temperature

Operation of these lamps is discussed in conjunction with engine monitor panel.

Test Lamp/Reset Switch: Press to test fault lamp bulbs (when engine is running only); manual reset for engine monitor after shutdown.

AC Panel

AC Ammeter: Indicates AC generator output current. Instrument is dual range (range in use shown on indicator lights).

Voltmeter-Ammeter Phase Selector Switch: Selects the phases of the generator output to be measured by the AC voltmeter and AC ammeter.

Frequency Meter: Indicates the frequency of the generator output in hertz. It can be used to check engine speed. (Each hertz equals 30 r/min.)

CONTROL PANEL INTERIOR

Voltage Regulator

Solid-state unit controls AC output from generator at predetermined level regardless of load. Regulation is plus or minus two percent from no load to full load, 0.8 power factor.

Engine Monitor

Printed circuit plug-in modules provide the following functions.

1. A 75 second cranking period
2. Approximately a 12.5 second time delay for oil pressure buildup
3. An external alarm contact to light a fault lamp and shut down the set to these alarm conditions
 - A. Overcrank (failed to start after cranking 75 seconds)
 - B. Overspeed (engine speed reaches 2100 r/min)
 - C. Low oil pressure (14 psi: 97 kPa)
 - D. High engine temperature (2315°F or 102°C)

CAUTION *The high engine temperature shutdown will shut down engine in an overheat condition only if coolant level is sufficiently high to physically contact shutdown switch. Loss of coolant will allow engine to overheat without protection of shutdown device, thereby causing severe damage to the engine. Therefore, maintain adequate engine coolant levels to ensure operational integrity of cooling system and engine coolant overheat shutdown protection.*

On standard control panels, all four alarms are wired into one common fault lamp; on units with five fault lamps, four have shutdown alarms, the fifth (low engine temperature) lights a fault lamp only. Refer to Table 1.

Standard Cranking Module

Limits engine cranking time to 75 seconds. If engine fails to start after 75 seconds, the engine monitor lights a fault lamp and opens the cranking circuit.

Optional Modules

Cycle Cranker: Plug-in module replaces standard cranking circuit. It automatically provides a 15 second crank time and a 10 second rest time for three ON and two OFF cycles in 65 seconds. If engine fails to start after 75 seconds, the engine monitor lights a fault lamp and opens the cranking circuit.

Pre-Alarm: Gives advance warning for low oil pressure or high engine temperature. Requires additional sensors for engine temperature and oil pressure.

Low Coolant Level Shutdown (Optional): A float actuated switch provides engine shutdown if coolant level falls too low. It also turns on the high engine temperature malfunction lamp.

STARTING PROCEDURE

The following sections cover the three systems used to start the generator set.

Starting at Control Panel

Move the Run-Stop-Remote switch on the DC panel to the RUN position. This will activate the engine control system and the starting system. The starter will begin cranking and after a few seconds the engine should start. The starter will disconnect when the engine reaches a speed of 450 to 570 r/min. The starter will also disconnect if the engine does not run after being cranked for a specified period of time.

Starting From Remote Location

Move the Run-Stop-Remote switch on the generator set DC panel to the REMOTE position. This allows the generator set to be started from a remote switch. Closing the remote switch initiates the starting sequence described in the previous section.

Automatic Remote Starting

Place the Run-Stop-Remote switch on the generator set DC panel in the REMOTE position if an automatic transfer switch is used. This allows the transfer switch to start the generator set if a power outage occurs.

Start-Up Checks

Observe the oil pressure gauge immediately after the engine is started. A normal oil pressure reading is between 45 and 65 psi (310 and 450 kPa). The following gauges should also be checked for normal readings:

DC Ammeter - Normal charging rate is 10 to 30 amperes.

AC Voltmeter - Generator output voltage should be stable and not vary more than $\pm 2\%$ of the rated value while under load.

Frequency Meter - Generator frequency should be stable.

Water Temperature - Run the generator set for about 10 minutes and then check the water temperature gauge. The engine should stabilize at 180 to 195°F (82 to 91°C). Some city water cooled generator sets have a valve in the water supply line for manually adjusting the water flow. Open or close the valve as required to maintain the desired water temperature while set is running under rated load.

STOPPING

Before Stopping

Run the generator set at no load for three to five minutes before stopping. This allows the lubricating oil and engine coolant to carry heat away from the combustion chamber and bearings.

To Stop

Move the Run-Stop-Remote switch or the remote starting switch to the STOP position.

OPERATING RECOMMENDATIONS

Some of the following sections require that a load be connected to the generator set. This is usually done using a load transfer switch. Refer to the transfer switch operator's manual for information on how the switch operates.

No-Load Operation

Hold periods of no-load operation to a minimum and avoid if possible. No-load operation allows combustion chamber temperatures to drop so low that the fuel does not burn completely. This results in carbon deposits which can clog injectors and cause piston rings and valves to stick. If it is necessary to run the engine for long periods at no load, connect a "dummy" electrical load to the generator.

Exercise Period

Generator sets on continuous standby must be able to go from a cold start to being fully operational in a matter of seconds. This can impose a severe burden on engine parts.

To avoid excessive engine wear, exercise the generator set at least once a week for minimum of 30 minutes. Run the set with a load applied to allow the engine to reach normal operating temperature. Exercising will keep the engine parts lubricated, maintain fuel prime, and prevent electrical relay contacts from oxidizing to insure reliable starts. Top off the fuel tank after each exercise period.

Onan automatic transfer switches have as an option an exerciser that can be preset to provide regular exercise periods. Typically, the exerciser can be set for time of start, length of run, and day of week.

High/Low Operating Temperatures

The following recommendations apply when operating the generator set in high (above 95°F/35°C) or low (below 50°F/10°C) ambient temperatures:

1. Use the correct viscosity oil for the most extreme expected ambient temperature conditions. If it is necessary to change oil, drain the oil only when engine is warm.
2. Use only fresh diesel fuel and keep the fuel tank completely filled to prevent condensation of moisture.
3. Keep the batteries fully charged and keep all battery connections clean and free of corrosion.

4. For low temperatures, use a water jacket heater if a separate source of power is available. The optional heater is available from Onan and will assure reliable starting under adverse weather conditions. Be sure the voltage of the separate power source is correct for the heater element rating. Various voltage and phase combinations are available.

Power Rating Factors

The generator set power rating applies to sets used in continuous standby applications. The set will operate at the stated rating for the duration of normal utility power interruptions. The rating was established for a standard radiator cooled set running on #2 diesel fuel and operating at an altitude of 500 feet (152 m) with an ambient temperature of 85°F (30°C). For a rating relative to other applications, altitudes, cooling systems, ambient temperatures, or fuels, contact an authorized Onan Distributor or the factory.

OUT-OF-SERVICE PROTECTION

If a generator set remains out of service for three or four weeks, special precautions must be taken to protect the engine from rust and corrosion. Contact the engine manufacturer for the recommended engine storage procedure.

Preparing Unit For Storage

The generator and control do not require any special storage procedures other than covering to prevent the entrance of dirt and moisture. The battery should be disconnected and stored in a cool, dry place. On a monthly basis, measure the specific gravity of the battery and check the electrolyte level. Add distilled water if below the split ring. Charge the battery if the specific gravity is below 1.250 at 77°F (25°C).

WARNING

Sparks might ignite battery gases and result in an explosion and severe personal injury. Do not disconnect battery cables from battery while generator set is cranking or running.

Returning Unit to Service

Generator sets that have been in storage require complete servicing and a thorough inspection before they can be returned to normal use. Contact the engine manufacturer for the recommended return to service procedures before starting the engine. Remove all protective covering from the generator and control and wipe off any accumulations of dust or dirt. Do not reconnect the battery until engine service is complete.

TROUBLESHOOTING

The generator set has a number of sensor units that continuously monitor the engine for abnormal conditions such as low oil pressure or high coolant temperature. If an abnormal condition does occur, the engine monitor will activate a fault lamp and external alarm and might also stop the engine depending on the condition. If the generator set does shut down, the operator might be able to restart the set after making certain adjustments or corrections. The following sections describe the operation of the fault condition system and list suggested troubleshooting procedures for the operation.

The standard control has a single fault lamp for indicating malfunctions and an external alarm for alerting the operator. The optional control has five fault lamps and an external alarm. See Table 1 for the fault lamp options.

TABLE 1. FAULT LAMP OPTIONS

SYSTEM	FAULT	FAULT LAMP	STOP ENGINE	EXTERNAL ALARM
STANDARD SINGLE LIGHT	Overcrank	x	x	x
	Overspeed	x	x	x
	Low Oil Pressure	x	x	x
	High Engine Temperature	x	x	x
5 LIGHT	Overcrank	x	x	x
	Overspeed	x	x	x
	Low Oil Pressure	x	x	x
	High Engine Temperature	x	x	x
	Low Engine Temperature	x		
5 LIGHT PRE-ALARM	Overcrank	x	x	x
	Overspeed	x	x	x
	Pre Low Oil Pressure	x		x
	Low Oil Pressure	x	x	x
	Pre High Engine Temperature	x		x
	High Engine Temperature	x	x	x
	Low Engine Temperature	x		

If the external alarm is activated, check the control panel to determine which fault lamp is lit. The procedures to follow for locating a problem and making corrections are covered in Tables 2 and 3. If a major problem is indicated, contact your Onan Distributor or the engine manufacturer for service.

Resetting the Control

The external alarm and fault lamp can be deactivated by placing the Run-Stop-Remote switch in the STOP position and pressing the Reset button. Locate the problem and make the necessary corrections before restarting the generator set.

TABLE 2
TROUBLESHOOTING ENGINE SHUTDOWN SYSTEM
(Engines with only one fault lamp)

SYMPTOM	CORRECTIVE ACTION
1. Engine stops cranking and fault lamp lights, after cranking approximately 75 seconds.	1. Check for empty fuel tank, empty fuel filters, system leaks, or plugged fuel filters and fuel supply lines. Correct as required.
2. Fault lamp lights immediately after engine starts and unit shuts down.	2. Indicates possible overspeed condition. Check the governor and throttle linkage for binding and freedom of movement. Contact an Onan Distributor or the engine manufacturer if linkage is not at fault.
3. Fault lamp lights and engine shuts down after running for a period.	<p>3. Check oil level and replenish if necessary. Contact Onan Distributor if oil level is correct.</p> <p>Check coolant level on radiator and heat exchanger sets and replenish if necessary.</p> <p>Check for slipping drive belts or for obstructions to the airflow.</p> <p>Check water flow valve on city water cooled sets and adjust if necessary.</p> <p>Contact an Onan Distributor or the engine manufacturer if none of the above.</p>
4. Engine runs, shuts down and cranks for 75-seconds. Cranking cycle stops; fault lamp lights.	<p>4. Check for dirty fuel filters and replace if necessary (see <i>MAINTENANCE</i> section).</p> <p>Check for dirty or plugged air filters and replace if necessary (see <i>MAINTENANCE</i> section).</p>
5. Fault lamp lights, no fault exists.	5. Engine monitor board or sensor malfunction. Contact an Onan Distributor.

TABLE 3
TROUBLESHOOTING ENGINE SHUTDOWN SYSTEM
(Units with five fault lamps)

SYMPTOM	CORRECTIVE ACTION
1. Overcrank fault lamp lights and engine stops cranking after approximately 75-seconds.	1. Check for empty fuel tank, empty fuel filters, system leaks, or plugged fuel filters and fuel supply lines. Correct as required.
2. Engine runs, shuts down, cranks for 75-seconds, cranking cycle stops, overcrank light on.	2. Check for dirty fuel filters and replace if necessary (see <i>MAINTENANCE</i> section). Check for dirty or plugged air filters and replace if necessary (see <i>MAINTENANCE</i> section).
3. Low oil pressure shutdown.	3. Check oil level and replenish if necessary. Contact an Onan Distributor if oil level is correct.
4. High engine temperature shutdown.	4. Check coolant level on radiator and heat exchanger sets and replenish if necessary. Check for slipping drive belts or for obstructions to the airflow. Check water flow valve on city water cooled sets and adjust if necessary. Contact an Onan Distributor or the engine manufacturer if none of the above.
5. Overspeed shutdown.	5. Check the governor and throttle linkage for binding and freedom of movement. Contact an Onan Distributor or the engine manufacturer if linkage is not at fault.
6. Overspeed light on, no shutdown. Low oil pressure light on, no shutdown. High engine temperature light on, no shutdown.	6. Engine monitor board or sensor malfunction. Contact an Onan Distributor.

Maintenance

Establish and adhere to a definite schedule for maintenance and service based on the application and severity of the environment. Table 4 covers the recommended service intervals for a generator set on standby service. If the set will be subjected to extreme operation conditions, the service intervals should be reduced accordingly. Some of the factors that can affect the maintenance schedule are the following:

- Use for continuous duty (prime power)
- Extremes in ambient temperature
- Exposure to elements
- Exposure to salt water
- Exposure to windblown dust or sand

Consult with an authorized Onan Distributor if the generator set will be subjected to any extreme operating conditions and determine a suitable schedule of maintenance. Use the running time meter to keep an

accurate log of all service performed for warranty support. Perform all service at the time period indicated or after the number of operating hours indicated, whichever comes first. Use the table to determine the maintenance required and then refer to the sections that follow for the correct service procedures.

SET INSPECTION

During operation, be alert for mechanical problems that could create unsafe or hazardous conditions. The following sections cover several areas that should be frequently inspected to insure continued safe operation.

Exhaust System

With the generator set operating, inspect the entire exhaust system visually and audibly including the exhaust manifold, muffler, and exhaust pipe. Check for leaks at all connections, welds, gaskets, and joints

TABLE 4. OPERATOR MAINTENANCE SCHEDULE

MAINTENANCE ITEMS	MAINTENANCE PERIOD					
	10 hrs.	50 hrs.	100 hrs.	200 hrs.	500 hrs.	6 mths.
Inspect generator set	x ¹					
Check oil level	x					
Check fuel filter for water and sediment	x					
Check coolant heater (if used)	x					
Check coolant level	x					
Check air cleaner (clean if necessary)		x ²				
Batteries		x				
Change engine crankcase oil			x ²			
Change oil filter			x ²			
Alternator and fan belt			x ³			
Drain condensate trap			x			
Change air cleaner element				x ²		
Drain fuel tank sediment				x ⁴		
Check heat exchanger plugs (if applicable)				x		
Clean generator assembly				x		
Change fuel filter					x	
Clean crankcase ventilation tube					x	
Clean cooling system						x

- 1 - Check for oil, fuel, cooling, and exhaust leaks. Check exhaust system audibly and visually with set running. Repair any leaks immediately.
- 2 - Or every 3 months, whichever occurs first. Perform more often for dusty conditions.
- 3 - Or every 3 months, whichever occurs first.
- 4 - Drain one cup of fuel to remove water and sediment.

and also make sure that exhaust pipes are not heating surrounding areas excessively. If any leaks are detected, shut down generator set and have them corrected immediately.

WARNING *Inhalation of exhaust gases might result in serious personal injury or death. Be sure dead exhaust gas is piped outside and away from windows, doors or other inlets to building.*

Fuel System

With the generator set operating, inspect the fuel supply lines, return lines, filters, and fittings for leaks. Check any flexible sections for cuts, cracks and abrasions and make sure they are not rubbing against anything that could cause breakage. If any leaks are detected, have them corrected immediately.

WARNING *Ignition of fuel might cause serious personal injury or death by fire or explosion. Do not permit any flame, cigarette, or other igniter near the fuel system.*

AC Electrical System

Check the following while the generator set is operating.

Frequency Meter: The generator frequency should be stable and the reading should be the same as the nameplate rating (50 or 60 Hertz).

AC Voltmeter: Turn the phase selector switch to each line-to-line phase selection shown on the volts scale (L1-L2 on single phase sets; L1-L2, L2-L3, and L3-L1 on three phase sets). Read the AC voltmeter using the upper or lower scale as indicated by the scale indicator light. At no load, the line-to-line voltage(s) should be the same as the set nameplate rating.

AC Ammeter (if equipped): Turn the phase selector switch to each phase selection shown on the amps scale (L1 and L2 on single phase sets; L1, L2, and L3 on three phase sets). Read the ammeter using the upper or lower scale as indicated by the scale indicator light. At no load, the current readings should be zero. With a load applied, each line current should be roughly the same.

Fault Lamps (Five-Fault Lamp Panels): Push the Test Lamp Button on the control panel. All indicator lamps should light. Verify that all of the bulbs are on and then release the switch. Replace any bulbs that are burned out.

DC Electrical System

Check the terminals on the battery for clean and tight connections. Loose or corroded connections create resistance which can hinder starting. Clean and

reconnect the battery cables if loose. Always connect the negative battery cable last to reduce the possibility of arcing.

WARNING *Ignition of explosive battery gases might cause severe personal injury. Do not smoke while servicing batteries.*

Mechanical

Follow warning below before proceeding. With the generator set stopped, check for loose belts and fittings, leaking gaskets and hoses, or any signs of mechanical damage. If any problems are found, have them corrected immediately. With the set running, listen for any unusual noises that may indicate mechanical problems and check the oil pressure frequently. Investigate anything that indicates possible mechanical problems.

WARNING *Accidental starting of the generator set might cause severe personal injury or death. Place the control switch in Stop position and disconnect the battery cable before inspecting set.*

LUBRICATION SYSTEM

The lubrication system must have oil of the recommended classification and viscosity. Refer to the *SPECIFICATIONS* section for the lubricating oil capacity.

Oil API Classification

The lubricating oil recommended in Table 5 satisfies the engine manufacturer's recommendations for satisfactory operation under most conditions. A book entitled "Lubricating Oils Data Book" is available from EMA (Engine Manufacturers Association) that lists commercially available oils by brand name and the corresponding API classification. Once an oil is selected, do not mix it with oils of another classification or add any oil additives.

Oil Viscosity

The viscosity of an oil is a measure of its resistance to flow at certain specified temperatures. Oils that can meet both low (0°F or -18°C) and high (212°F or 100°C) temperature flow requirements are labeled as multigrade or multiviscosity oils. Multigrade oils that meet the API classification requirements are recommended for use in the engine by the engine manufacturer. The use of a multigrade oil will improve oil control, improve engine cranking in cold weather, maintain adequate lubrication, and may also contribute to improved fuel economy.

TABLE 5

AMBIENT TEMPERATURE	SINGLE VISCOSITY	MULTI-VISCOSITY
Below - 10° F (-23° C)	SAE 5W	SAE 5W20
Between -10° F and 32° F (-23° C and 0° C)	SAE 10W	SAE 10W30
Above 32° F (0° C)	SAE 30	Not Recommended
Use oil conforming to these specifications	API CD/SD MIL-L-2104C* Series 3	API CC/SE MIL-L-46152

* API CC or CD

Engine Oil Level

Check the engine oil level during engine shutdown periods at the intervals specified in the Maintenance Table. Figure 17 shows the dipstick and oil fill locations. The dipstick is stamped with high and low marks to indicate the level of oil in the crankcase. For accurate readings, shut off the engine and wait a few minutes before checking the oil level. This allows oil in the upper portion of the engine to drain back into the crankcase.

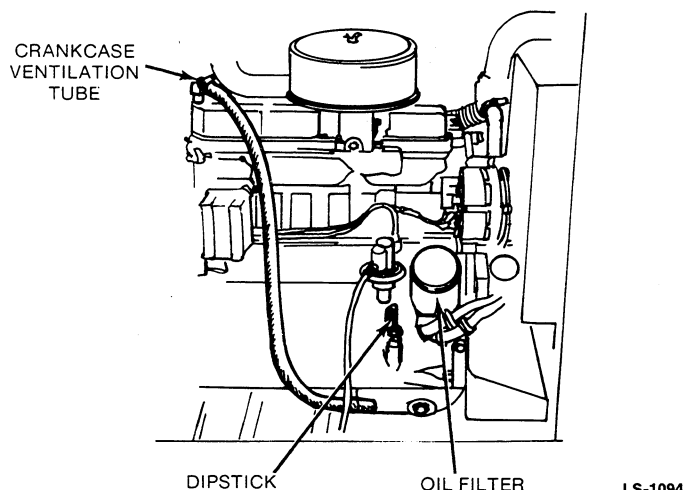


FIGURE 17. LOCATION OF OIL FILTER, DIPSTICK AND CRANKCASE VENTILATION TUBE

WARNING *Crankcase pressure could blow out hot oil and cause serious burns. Do NOT check oil while the generator set is operating.*

Keep the oil level as near as possible to the high mark on the dipstick. Remove the oil fill cap and add oil of the same quality and brand when necessary.

CAUTION *Do not operate the engine with the oil level below the low mark or above the high mark. Overfilling causes foaming or aeration of the oil while operation below the low mark causes loss of oil pressure.*

Oil and Filter Change

Change the oil and filter at the intervals recommended in the maintenance table. Use oil that meets the engine manufacturer's API Classification and viscosity requirements as indicated in the previous section.

Engine Oil Change:

1. Bring the engine up to operating temperature and then shut off.
2. Open the drain valve and collect the engine oil in a pan. When the crankcase is drained, close the drain valve.
3. Fill the crankcase with the amount of oil noted in the *SPECIFICATIONS* section.
4. Start the engine and check for oil leaks.
5. Shut off the engine, wait a few minutes, and then check the oil level. Add oil if required.

WARNING *Crankcase pressure could blow out hot oil and cause serious burns. Do NOT check oil while the generator set is operating.*

Oil Filter Change:

1. Unscrew the "spin-on" type oil filter and discard (see Figure 17).
2. Apply a light coat of oil to the gasket sealing surface of the new filter.
3. Install new filter and tighten by hand until the gasket just touches the filter band. Tighten an additional one-half to three-fourths turn.
4. Start the engine and check for leaks.
5. Shut the engine off and wait a few minutes, and then check the oil level. Add oil if required.

WARNING *Crankcase pressure could blow out hot oil and cause serious burns. Do NOT check oil while the generator set is operating.*

CRANKCASE VENTILATION TUBE

To clean the ventilation tube, loosen the hose clamp at the upper end of the tube shown in Figure 17. Clean it with diesel fuel (note following warning). Service more frequently if operating in dusty conditions.

WARNING *Fuel presents the hazard of fire and explosion that might cause serious personal injury or death. Do not permit any flame, cigarette, or other ignition source near the fuel.*

FUEL SYSTEM

Recommended Fuel

The engine has been primarily designed to operate on No. 2 diesel fuels since such fuels have a higher energy content and are generally lower in cost. Use No. 1 fuel for temperatures below 40°F (4°C) or for all temperatures if altitudes are above 5000 feet (1500 m). The fuel should have a cetane rating of at least 40 and have less than one percent sulfur (less 0.5 percent if possible).

Fuel Handling Precautions

Take appropriate precautions to prevent the entrance of dirt, water, or other contaminants into the fuel system. Filter or strain the fuel as the tank is filled.

WARNING Ignition of fuel might cause serious personal injury or death by fire or explosion. Do not permit any flame, cigarette, or other igniter near the fuel system.

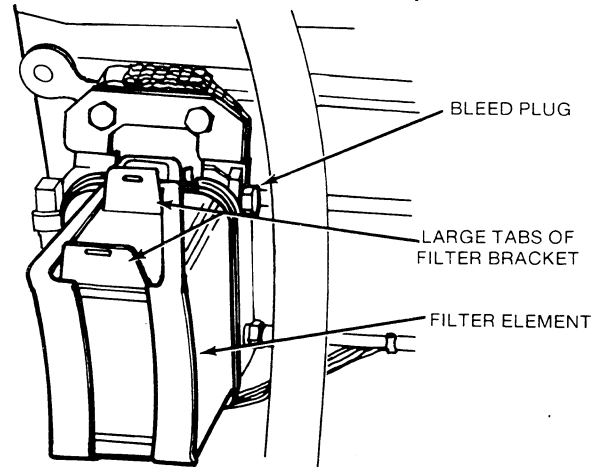
To avoid condensation problems, keep fuel supply tanks as full as possible by filling up each time the engine is used. In cold weather, warm fuel returning from the injectors heats the fuel in the supply tank. If the fuel level is low, the upper portion of the tank tends to form condensation. In warm weather, both the fuel and the tank will be warm during the daytime. At night, cool air tends to lower the temperature of the tank more rapidly than the temperature of the fuel. If the fuel level is low, the upper portion of the tank will cool more rapidly and tend to form condensation.

Condensation (water) can cause clogging of fuel filters as well as freezing problems. In addition, water mixing with the sulphur in the fuel forms acid which can corrode and damage engine parts.

Fuel Filter

To remove the fuel filter and install a new one, use this procedure.

1. Move the Operation Selector switch to STOP.
2. Drain the filter before removing it, if you want, by removing the drain plug on the bottom of the filter body and catching the fuel in a suitable container. Figure 18 shows filter. Put the plug back when finished.
3. Squeeze the two top large tabs of the filter bracket together and pull the top of the bracket toward you. As the top comes loose, grab the filter and remove the bottom of the filter bracket. The filter should now be loose.
4. Clean the filter body and install a new filter element.
5. To fill the filter body, see step 1 of the procedure Priming Fuel System.
6. Move the Operation Selector switch to REMOTE.



FS-1419

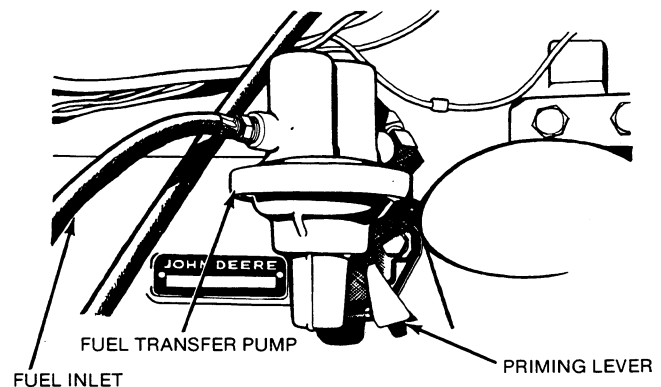
FIGURE 18. FUEL FILTER

Priming Fuel System

Priming cannot be performed unless all connections in the fuel system are secure and no leaks exist. Proceed with priming as follows:

1. Loosen bleed plug on top of fuel filter. Pump primer lever (Figure 19) until a solid stream of fuel, free of air bubbles, flows from bleed plug.
2. Secure bleed plug.
3. Loosen inlet fuel line on injection pump. Operate primer lever on fuel transfer pump until a solid stream of fuel, free of air bubbles, flows from inlet line opening.
4. Secure injector pump fuel inlet line.
5. Leave fuel transfer pump priming lever at lowest point of stroke.

If the primer lever will not pump and no resistance is felt at upper end of stroke, turn engine over with starter to change position of fuel pump drive lobe on camshaft.



FS-1420

FIGURE 19. PRIMING FUEL SYSTEM

BATTERIES

Check the condition of the starting batteries at the interval specified in the maintenance table. See that connections are clean and tight. A light coating of non-conductive grease will retard corrosion at terminals. Keep the electrolyte at the proper level above the plates by adding distilled water. Check specific gravity and recharge if below 1.260.

WARNING

Ignition of explosive battery gases might cause severe personal injury. Do not smoke while servicing batteries.

ALTERNATOR AND FAN BELT

Inspect the belts regularly for wear, cracks, or fraying. Replace if necessary. To check tension, first move the Operation Selector switch to OFF. Then place a force of 20 pounds (89 N) midway between the pulleys. If adjusted properly, the belt should deflect 3/4 inch (19 mm).

WARNING

Contact with rotating machinery might cause serious personal injury or death. Be sure to move the Operation Selector switch to OFF before checking fan belt tension or before making any adjustments.

Be sure to loosen both the adjusting strap and bracket capscrews when making adjustments. Pull on the front alternator frame only to tighten the belt.

AIR CLEANER

Check the air cleaner element and replace it at the recommended intervals in the maintenance table.

1. Remove the thumbscrew from the top center of the air cleaner cover. See Figure 20.
2. Carefully remove the air cleaner cover making sure no dust or dirt enters the air intake.
3. Carefully remove the element from air cleaner.
4. Wipe out the interior of the air cleaner housing and cover with a damp cloth.
5. Install a new element if that service interval is reached. If not, shake out excess dirt or tap element to remove dirt. Do NOT wash. Check the element for cracks, holes, or tears (replace if you find any). Re-install element in the housing.
6. Put on air cleaner cover and secure with the thumbscrew.

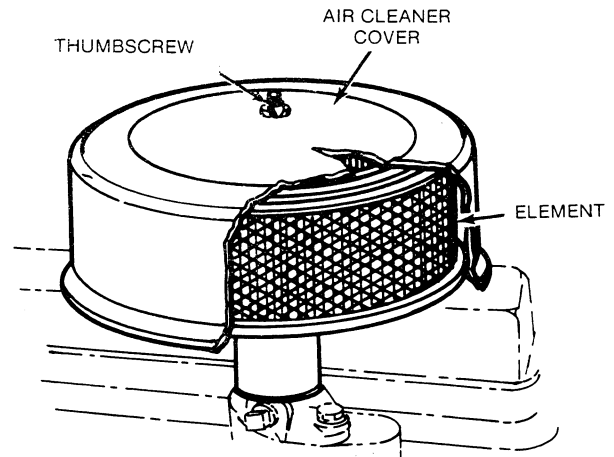


FIGURE 20. AIR CLEANER

FS-1418

COOLING SYSTEM

The cooling system capacity of the standard unit with set mounted radiator is shown in the *SPECIFICATIONS* section.

CAUTION

The heater must not be operated while the cooling system is empty or when the engine is running or damage to the heater will occur.

Coolant Requirements

The water used for engine coolant should be clean, low in mineral content, and free of any corrosive chemicals such as chloride, sulphate, or acid. Generally, any water that is suitable for drinking can be treated for use as engine coolant.

Cooling systems that are subject to freezing conditions must also be protected with a permanent type antifreeze. Mix the water and antifreeze in the proportion recommended by the supplier for the lowest expected ambient temperature.

WARNING

Contact with hot coolant might result in serious burns. Do not bleed hot, pressurized coolant from a closed cooling system.

Filling the Cooling System (Radiator and Heat Exchanger Sets)

Remove the cooling system pressure cap and fill the system with water or a water/anti-freeze mixture. When the engine is first started, remove the pressure cap and monitor the coolant level. As trapped air is expelled from the system, the coolant level will drop and additional coolant should be added. Replace the pressure cap when the coolant level is stable.

CAUTION

Be sure the electric solenoid valve used with city water cooled sets is open before initial starting of unit to allow coolant chambers to fill. Otherwise overheating and damage to the engine might result.

Standpipe Cooled Sets

With a standpipe cooled set, cooling water is discharged and replaced rather than being cooled and recirculated. The cooling water must be clean and free of any contaminants to prevent the engine water jacket passages from becoming clogged.

CAUTION *Be sure that the electric solenoid valve used with city water cooled sets is open before initial starting of unit to allow coolant chambers to fill. Otherwise overheating and damage to the engine might result.*

Coolant Level

Check the coolant level during shutdown periods at the intervals specified in the maintenance table. Remove the radiator cap after allowing the engine to cool and if necessary, add coolant until the level is near the top of the radiator. Use a coolant solution that meets the engine manufacturer's coolant requirements.

WARNING *Contact with hot coolant might result in serious burns. Allow cooling system to cool before releasing pressure and loosening tank heater lines.*

Coolant Heater

Check the operation of the coolant heater by verifying that hot coolant is being discharged from the outlet hose (see Figure 21). For efficient operation and maximum life, clean the coolant heater whenever the cooling system is drained for flushing.

1. Remove AC power from coolant heater.

WARNING *AC power presents the hazard of serious personal injury or death. Be sure to remove AC power before cleaning.*

2. Allow heater to cool before proceeding.

WARNING *Contact with hot coolant might result in serious burns. Do not bleed hot, pressurized coolant from a closed cooling system.*

3. Drain the coolant into a container.

- A. Open the radiator drain cock.
- B. Open the coolant heater drain cock on bottom of heater if equipped. See Figure 21.

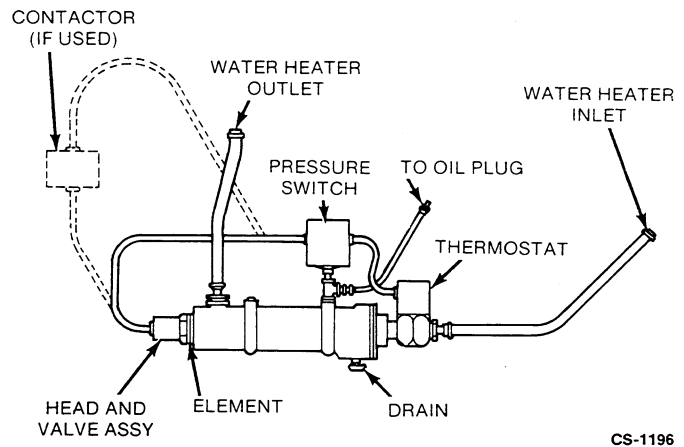


FIGURE 21. COOLANT HEATER

4. Remove the head and valve assembly.
5. Clean any scale deposits out of the tank.
6. Remove heating element and scrape off any scale deposits that have accumulated on the sheathing.
7. Reassemble the heater.

CAUTION *When reassembling threaded aluminum parts, be sure to use anti-seize compound.*

8. Restore AC power to heater after system has been filled with coolant.

Flushing and Cleaning Cooling System

1. Add John Deere system cleaner or flush solution, or radiator cleaning compound to the radiator as instructed on the container. Also follow instructions for running the unit, etc. Proceed to step 2 when instructed to stop the engine.
2. Move the Operator Selector switch to STOP.
3. Remove AC power to the coolant heater if equipped.

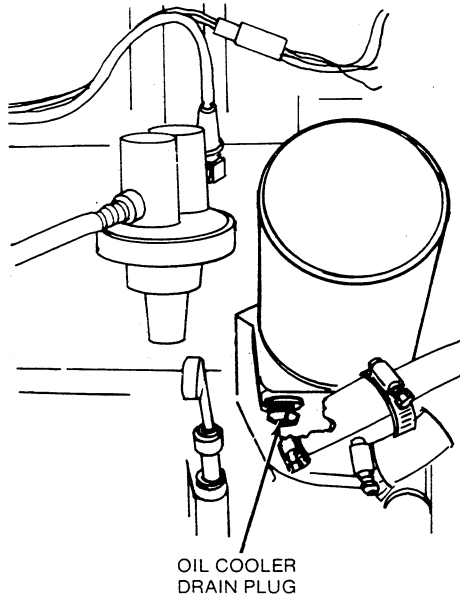
CAUTION *Failure to disconnect AC power from the heater before draining coolant will result in heater damage.*

4. Drain the cooling system. Wait for the engine to cool.

WARNING

Contact with hot coolant might result in serious burns. Drain coolant into containers with great care.

- A. Open the radiator drain cock.
- B. Open the engine block drain cock which is located on the block next to the starter.
- C. Remove the engine oil cooler drain plug if equipped. See Figure 22.
- D. Open the coolant heater drain cock on bottom of heater if equipped. See Figure 21.



LS-1093

FIGURE 22. COOLANT DRAIN PLUG FOR OIL COOLER

5. Flush cooling system if so instructed by cleaner or flush solution manufacturer. Do not add cold water or solution to a warm engine.

CAUTION

Adding cold solution to a warm engine might result in engine damage.

6. Close all the drain cocks and insert oil cooler drain plug (if applicable).
7. Add coolant as follows:
 - A. For temperatures below freezing, fill the cooling system with 50 percent water and 50 percent ethylene glycol antifreeze with approved rust inhibitor.
 - B. For temperatures above freezing, fill the cooling system with antifreeze and water as noted in "A", or with water and add a non-chromate rust inhibitor every three months or every 500 hours.

8. Reconnect AC power to the coolant heater if applicable.
9. Move the Operation Selector switch to its desired position.

AC GENERATOR

General

There are no brushes, brush springs or collector rings on these generators, therefore they require very little servicing. Periodic inspections, to coincide with engine oil changes, will ensure good performance.

Check generator voltage. It might be necessary to make a slight readjustment of the voltage rheostat to obtain the preferred voltage at average load.

Inspection of Rotating Rectifier Assembly

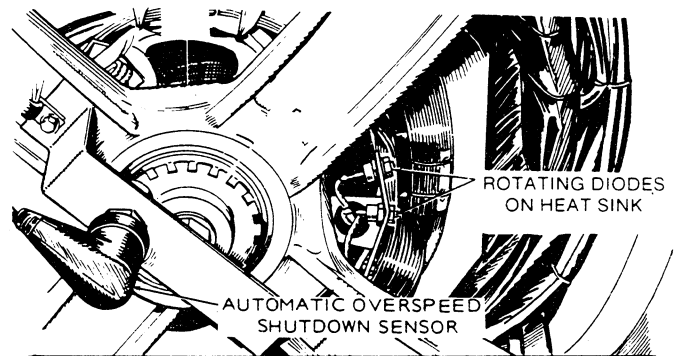
Move the Operation Selector switch to STOP, disconnect the starting batteries, and then remove the grill section. Inspect the rotating rectifier assembly to make sure the diodes (see Figure 23) are free of dust, dirt, and grease. Excessive foreign matter on these diodes and heat sinks will cause the diodes to overheat and will result in their failure. Blow out the assembly periodically with filtered low pressure air.

WARNING

Accidental starting of the set might cause severe personal injury or death. Move the Operation Selector switch to STOP and disconnect the starting batteries before inspecting rotating rectifier assembly.

Generator Bearing

Have the bearing inspected for wear every 1000 hours by an Onan service representative. If the unit is used for "prime power," have the bearing replaced every 10,000 hours or after two years. If the unit is used for "standby power," have the bearing replaced every five years.



ES-1302

FIGURE 23. RECTIFIER ASSEMBLY

